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An empirical analysis of beliefs about climate change challenges

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Abstract

In the last decades, one of the main efforts of the Common Agricultural Policy was to promote a better use of natural resources in agricultural and food production. The adoption of environment-friendly technology depends in turn on farmers beliefs in the different solutions offered by the knowledge-based systems. In this context, farmers beliefs are recognized to be the critical drivers of the possibilities of adopting new technologies in the field of climate change mitigation. This study considers the beliefs as drivers of the farmers evaluation of the possibility to contribute to climate change mitigation and frame them in wider conceptual framework of institutional change. The objective of the study is to address the question on whether or not the farmer beliefs about technology influence the potential farming activities contributions to mitigation. The results of the empirical analysis confirms the role of the beliefs and of their institutional dimensions.

Kewywords
climate change, beliefs, institutions

Introduction

In the last decades, one of the main efforts of the Common Agricultural Policy was to promote a better use of natural resources in agricultural and food production. Farmers can contribute to climate change mitigation adopting adequate technology. In the recent Reform one third of the funds will be given as Direct Payments ("green") and the Rural Development Plan will press for investment in environmental sustainability. All these tools aim to promote sustainability and improve environment-friendly technology. On the other hand, the heterogeneity of the areas and the conditions of the natural resources that control the agricultural process often challenges the environment regulation (Hasund, 2013). However, both at European and National level, will be more effective if farmers will rapidly change their production behavior (Burton and Schwarz, 2013). The participation of farmers in the environmental schemes specification seems to allow a better effectiveness of the instruments, both from the environment point of view and from the reorganization of the company and its competitiveness (Westhoek et al., 2013). The adaptation of an environmental-friendly technology innovate the farming production system and support the

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farmer contribution to the climate change mitigation. The institutions sustain and frame the technological change and adaptation (North, 1990). Accordingly, Dovers and Hezri (2010, pp. 216-217) pointed out that adaptation and mitigation strategies require institutional change. The adoption of environment-friendly technology depends in turn on farmers beliefs in the different solutions offered by the knowledge-based systems. In this context, farmers beliefs are recognized to be the critical drivers of the possibilities of adopting new technologies in the field of climate change mitigation (Grothman and Patt; Dietz *et al.*, 2007; Vainio and Poliniemi, 2011). This study considers the beliefs as drivers of the farmers evaluation of the possibility to contribute to climate change mitigation and frame them in wider conceptual framework of institutional change (North, 2006). The objective of the study is to address the question on whether or not the farmer beliefs about technology influence the farmer expected contributions to climate change mitigation. The specific contribution of the study is to frame the analysis of beliefs influence in the context of the institutional change. We considered a large sample of Italian farmers and elicited their evaluation of these potential contributions. The mains result of the study is while the farmers beliefs are able to influence the potential mitigating contribution, these relationship have to be framed in a wider context in which not only economic incentives but also the farmers practices play a role.
The paper is organized as follows. The paragraph 2 presents the conceptual framework of the study. The method of the empirical investigation is illustrated in paragraph 3. The paragraph 4 is dedicated to the results and their discussion. The conclusions are presented in the paragraph 5.

Conceptual framework

Theoretical background

Scholars widely recognize the potential contributions of farming activities to the mitigation of the climatic change. In the field of climate change policies a particular attention is given to investigate preferences and factors contributing to higher levels of policy support. Agricultural policies have progressively included objectives related to the mitigation of climate change and to the promotion of the adoption of adequate technologies. The focus is to create an increasing awareness in the society as a wool of the need of responsible behavior and practices to face the environment challenges. One of the main goals of European environmental policies is to recruit local-level actors to fulfill set targets (Kaljonen, 2006). A more pro-environmental behaviors is based on the construction of shared rules that affect simultaneously the whole socio-economic systems. (Lucas *et al.*, 2008).
We contend that three analytical levels have to be considered in the field of climate change: the individual beliefs, the social process shaping the technology adoption and the scale problem affecting the climate change perception. Our proposal is to frame and to interpret these analytical levels in the context of the Aoki (2011) model of institutionalization.
An increasing evidence is underlining the role of farmers beliefs in the adoption of environmental-friendly technologies. Beliefs are recognized having critical importance of

potential mitigation of climatic change (Dietz *et al.,* 2007; Blennow and Person, 2009). Arbuckle *et al.*, (2013) identified a complex relationship between the regulation framework and beliefs about climatic change. Grothmann and Patt (2005) pointed out a potential relation between the farmers' strength of beliefs in climate change and adaptive measures taken by them to reduce the negative consequences of climate change. It is then recognized that the adaptation to climate change is influenced to a considerable degree by his strength of belief in climate change. Prokopy *et al.* (2015) underlined the necessity of understanding the farmers beliefs about climate change not only in order to channel the appropriate communication efforts, but mainly to the ends of effective policy design. However there is still a need to connect analytically the beliefs concerning the multiple dimension of the climate change to a comprehensive framework.

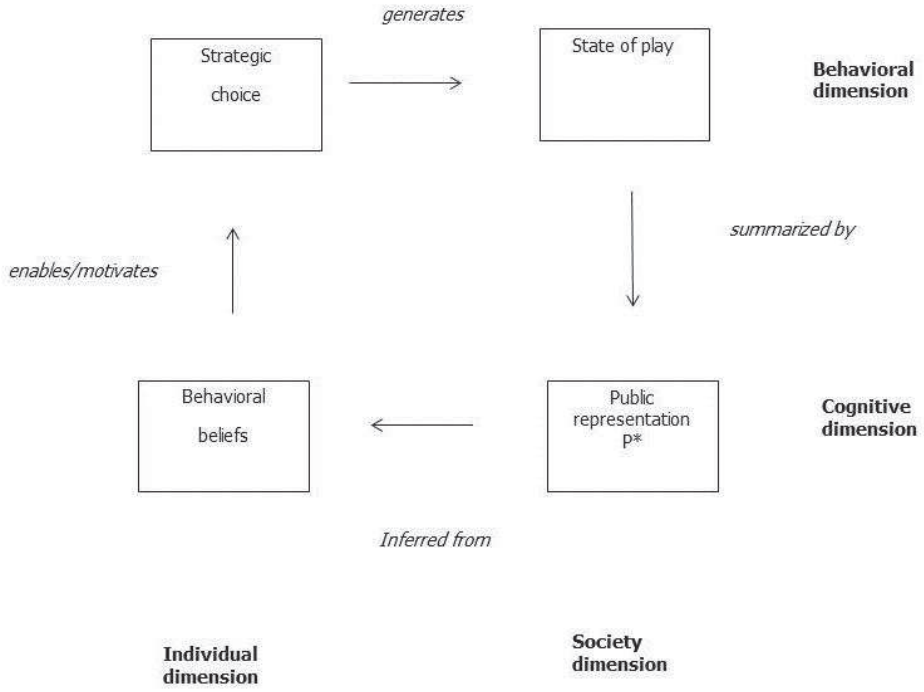
The second analytical element to be considered concerns with the social processes which could shape the farmers beliefs in the perspective of the change required to implement mitigating technologies. We consider it as a multiple reality made up of different cultural perceptions, social and institutional interests in which the main outcome depends from the on going interrelations between social and political actors (Long and Van Der Ploeg, 1989). The collective change is a precarious process (Callon, 1986); it depends not only by the actors who built it, but also by social and material entities involved. In other words, the change of the collective behavior of the farmers is a process based on the interactions between political choices impacts on natural resources, new societal needs and long-term economic objectives. The farmer's effectiveness perception of these environmental schemes is a social constructed knowledge based on the social networks, in which the farmers are embedded, and on the practices that are shared in the networks (Murdoch, 1997, 1998 and 2001).

The third analytical level concerns with the general perspective in which a change in technology and practices aimed to promote the mitigation of climatic change have to allocated. Climatic change has an inherent scale problem. It happens at large geographic areas scale and it is not easily perceived at individual scale (Vainio, Palomieni, 2011). Haarstad (2014, pp. 88-89) argued that the fragmentation and the disconnection of the natural resources scales make difficult the implementation of the governance patterns. A critical role in solving the scale problem is played by the institutional framework (Haarstad, 2010; Ostrom, 2007, 2009). Therefore, on the one hand the adoption of mitigating technologies have to take place at large scale level; on the other hand, the individual beliefs have to be framed within a public discourse which tends to implement the institutional change (North, 2005).

Our proposal is to frame the beliefs, the social processes and the scale problem by through the Aoki (2011) institutionalization model. According to the Aoki (2011) theory we focus our attention on the importance and the role that beliefs as regards other's actions and beliefs plays in social interactions. Aoki (2011) showed that the emerging of a new institutional dimension is the outcome of a recursive interaction among behaviors, public representation of the relevant phenomenon – in our case the climatic change – and the consequent actors behaviors.

Substantially, the author affirm that a public proposition *P** mediating the stable physical states of play (strategic interactions) and individual beliefs in recursive ways may be referred to as a *substantive form of an institution*. The recursive cycle is depicted in the Figure 1.

Figure 1. The recursive model of institutionalization



Source: Aoki (2011)

Interestingly, the model coordinates the individual level to the society dimension. The public representation at the society level contributes to the behavioral beliefs which in turn support the individual choices. This behavioral dimensions at the society level is thus the consequence of the causal nexus originated by the individual choice and of the recursive nature of the process. In the model the beliefs individual dimension is analytically connected to the institutionalization and this in turn is substantiated by the stability of the behaviors through the time.

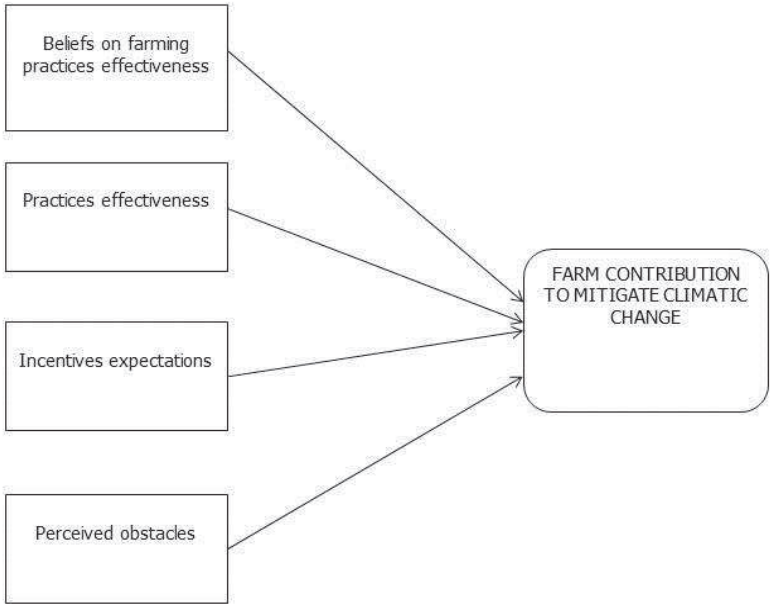
The analysis of the farmer beliefs in the context of the climate change is connected to (and contribute to) the public representation of the phenomenon. Moreover, this perspective allows one to recognize the role the farmers beliefs may have to trigger a stable change in the farming systems.

Model and research question

To study purpose, the Aoki model provides a robust theoretical framework to the three analytical levels mentioned: farmers beliefs, social processes and scale problems. This theoretical framework allows on to draw many analytical conceptualization and to support effective specific operationalization.

Our research question relates to how the farmers beliefs contribute to the expected contribution of farm activities to climate change mitigation. Our focus is on the adoption of the technology at the individual level. Therefore to consider farmers beliefs it is necessary to account also for the further drivers active at the individual farmer level. Davis (1989) addressed this issue pointing out that the adoption of given technology is crucially dependent on the causal nexus between the attitude toward the technology and the behavior of the agents. On the other hand, beliefs are the cognitive bases of the attitudes and the evaluative states that intervene between a class of stimuli (e.g. the sensorial characteristics of a products) and a class of evaluative responses (Petty *et al.*, 1997). According to Fazio (1986) and Ajzen and Fishbein (1980) attitudes and norms interact at the basis of the behavior. Incentives are also a driver of adoption of specialized technologies (Davis, 1989), while perceived potential difficulties can reduce the farmer propensity to adopt the specialized technology. Practices are institutional elements (Jones and Murphy, 2010) contributing to the technology adoption process (Nelson, 1994; Brown, Duguid, 1991). Beyond farmers beliefs, the practices already undertaken play a great role in determining the subsequent farmers innovative behavior (van der Ploeg, 2004).
We propose in the figure 2 the conceptual model which support the empirical analysis.

Figure 2. Determinants of the effectiveness of the farms contribution to the mitigation of climatic change



Source: own elaboration

Our specific research questions is thus: *do the farmer beliefs about technology influence the farmer expected contributions to climate change mitigation?*
We namely considered the potential importance of the contribution as evaluated by the farmers and addressed the research question by analyzing the data gathered by a survey carried out at a large farms sample. We expect that beliefs of management of agricultural practices, the farming practices already implemented and the incentive expectations have a positive influence of the farmers evaluation of the potential effectiveness in terms of mitigation contributes, while the perceived obstacle are expected to have a negative influence.

Method of empirical analysis

To the purposes of the empirical analysis we administrated a survey gathering 1,007 interviewees. The population universe of departure for the extraction of the sample consists of all farms that in 2008 received the CAP single payment over 2000 Euros registered inside the SIAN (National Agricultural Information System) and corresponds to a total number to 300,317 units. The farms were stratified by region and class premium amount. From the starting stratified population, was extract a random sample of approximately 6,000 units to provide at least 1,000 useful responses from the telephone survey. The sampling design used was proportional, while the sample size has been set requiring that the representativeness of the sample was approximately equal to 0.3% of the population overall. The investigative questionnaire was administered during the period June-July 2010. The variable considered in the analysis are illustrated in the Table 1. The farmers sampled were requested to evaluate the potential contribution of the farm to the mitigation of the climate change (1=null; 2=low; 3=high; 4=very high). An ordered logit model was the estimated where the answer was managed as a dependent variable. The endogenous variables are presented in the Table 1. We considered beliefs which concerns aspects of technology supposed to be influential on climate change. A specific question was submitted about the practices the farmer may has already undertaken in the field of climate change mitigation. Moreover a question concerning the expectation in terms of economic incentives was also submitted. The perception of potential obstacles was also considered.

Table 1. List of endogenous variables

Variable	Symbol	Meaning	Coding
Beliefs about technology aimed at climate cange mitigation	BEL_FERT	Respondent believes that the reduction of fertilizers uses may mitigate climate change	0=NO; 1=YES; 2=Do not know
	BEL_ENER	Respondent believes that abetter nergy efficiency may mitigate climate change	0=NO; 1=YES; 2=Do not know
	BEL_SOILM	Respondent believes that better soil management practices may mitigate climate change	0=NO; 1=YES; 2=Do not know
	BEL_REDUC	Respondents believes that the reduction of crop intensity may mitigate climate change	0=NO; 1=YES; 2=Do not know
	BEL_WOOD	Respondents believes that wood planting may mitigate climate change	0=NO; 1=YES; 2=Do not know
	BEL_FIREP	Respondents believs that fire prevention may mitigate climate change as measure of local context preservation	0=NO; 1=YES; 2=Do not know
Practices effectiveness	PRACT_CLIM	Practices aimed at mitigation of climate changes already carried out by the respondent	0=NO; 1=YES; 2=Do not know
Incentives expectations	CLIM_INC	Principal component, summarizing respondents expected incentives: -Agroenvironment payments for reducing agricultural gas emission -Training/Information for processes enhancement -Investments in reduction of gas emissions -Wood plantation -None	
Perceived obstacles	RESEARCH	Perceived lack of research	0, 1
	FINANC	Perceived lack of financial resources	0, 1
	INFORM	Perceived lack of information	0, 1
	TECHASSIST	Perceived lack of technical assistance	0, 1
Control variables	SECTOR	Cereals, Vegetables, Arable crops, Viticolture, Olive crop, Fruits Orchard Cattle, Pork, Sheep, Poultry, Other animal	0, 1
	ATTAGR	Field of activity: agriculture	0, 1
	AXIS_2	Amount of public funds from *Axis 2 - Improving the environment and the countryside*	Euro
	AGE_1	< 40 years	0, 1
	AGE_2	40-60 years	0, 1
	AGE_3	> 60 years	0, 1

Source: own elaboration

Results

The characteristics of the sample are presented in the Table 2. The model estimated is presented in Table 3.

Table 2. Descriptive characteristics of the sample's firms

Sample characteristics	Sample frequency (%)	Sample characteristics	Sample frequency (%)
Geographic area		***Main activity***	
North Italy	41.7	Agriculture	79.6
Central Italy	16.5	Not agriculture	5.9
South Italy	41.8	Don't answer	14.5
Age (years)		***Education***	
≤ 40	12.1	Primary school	23.2
41 - 60	35.7	High school	22.3
> 60	30.1	University	8.7
Don't answer	22.0	Don't answer	45.7
Sector		***Firm typology***	
Cereals	31.3	Capitals society	1.0
Horticulture	1.2	Society of persons	24.3
Arable	11.0	Simple society	38.0
Wine	2.7	Cooperative	0.8
Olive	8.3	Other	2.3
Fruit	3.2	Don't answer	33.6
		Revenue	
Wood	0.8	*(Euro/year)*	
Bovine breeding	19.3	≤ 10000	13.1
Pork breeding	1.4	10000-50000	15.7
Sheep and goat breeding	4.2	51000-150000	8.6
Chicken breeding	0.4	151000-300000	2.3
Mixed breeding	4.4	>300000	3.1
Other	11.9	Don't answer	57.2

Source: own elaboration

The variables concerning the economic incentives were summarized by a principal component (Cronbach's Alpha =0.54, resulting in a poor level) in order to account for the whole set of farmer expectations.

Table 4: Order logit model

Climate	Coef.	Std. Err.	z	P>z
BEL_FERT	-0.661	0.335	-1.97	0.05
BEL_ENER	-0.282	0.442	-0.64	0.52
BEL_SOILM	-0.891	0.413	-2.16	0.03
BEL_REDUC	-0.262	0.438	-0.60	0.55
BEL_WOOD	-0.662	0.456	-1.45	0.15
BEL_FIREP	-0.616	0.491	-1.26	0.21
RESEARCH	0.518	0.198	2.62	0.01
FINANC	0.191	0.183	1.04	0.30
INFORM	-0.468	0.208	-2.24	0.03
TECHASSIST	-0.265	0.238	-1.12	0.27
clim_inc	0.456	0.150	3.05	0.00
pract_clim	0.444	0.481	0.92	0.36
aXIS_2	0.002	0.001	2.19	0.03
Cereals	0.192	0.371	0.52	0.61
Vegetables	1.127	1.017	1.11	0.27
Arable crops	0.729	0.465	1.57	0.12
Viticolture	0.833	0.703	1.19	0.24
Olive crop	1.369	0.758	1.81	0.07
Fruits	1.013	0.695	1.46	0.15
Orchard	0.557	1.610	0.35	0.73
Cattle	0.411	0.419	0.98	0.33
Pork	-0.044	0.891	-0.05	0.96
Sheep	1.186	0.785	1.51	0.13
Poultry	0.648	2.181	0.30	0.77
Animal var.	0.281	0.690	0.41	0.68
attagr	0.339	0.474	0.72	0.47
AGE_1	-0.468	0.354	-1.32	0.19
AGE_2	-0.349	0.288	-1.21	0.23
/cut1		-2.104	1.112	
/cut2		0.022	1.114	
/cut3		3.843	1.125	

Source: own elaboration

The variables *BEL_FERT* and *BEL_SOIL* have statistically significant coefficients indicating that in the samples these beliefs explain the evaluation made by the farmers. Among the obstacles *RESEARCH* and *INFORM* are also significant as well as the *AXIS_2* and *CLIM_INC*. In the present ordered logit models, the Average Marginal Effects (AMEs) provide a measure of the impact of a unit change in a variable on the probability of the rank (1, 2, 3 or 4) expressed by the respondents. The Graph.1 illustrates average marginal effects for *BELIEF_Fert* and *BELIEF_Soilm*. Both these two variables have a positive impact on *Null* and *Low* probability that the agricultural practices may contribute to mitigate the climate change. The increase of a unit (from 0 to 1) of the variable *BELIEF_Fert* causes the increase of the

probability of the rank=1 by the 6.54%, while the increase determined by *BELIEF_soilm* is 8.81%. The increase of the probability that a respondent would rank=2 the farmer contribution to the climate policy challenges are 5.1% and 4% respectively for the two variables. The picture changes in the case of the two remaining ranks. In both cases an increase of the two variables determine a decrease of the probability, by 5.62% and -7.58%. The respondents' believe that the contribution of the specific farming practices have just a weakly impact on the policy challenges concerning climate change.

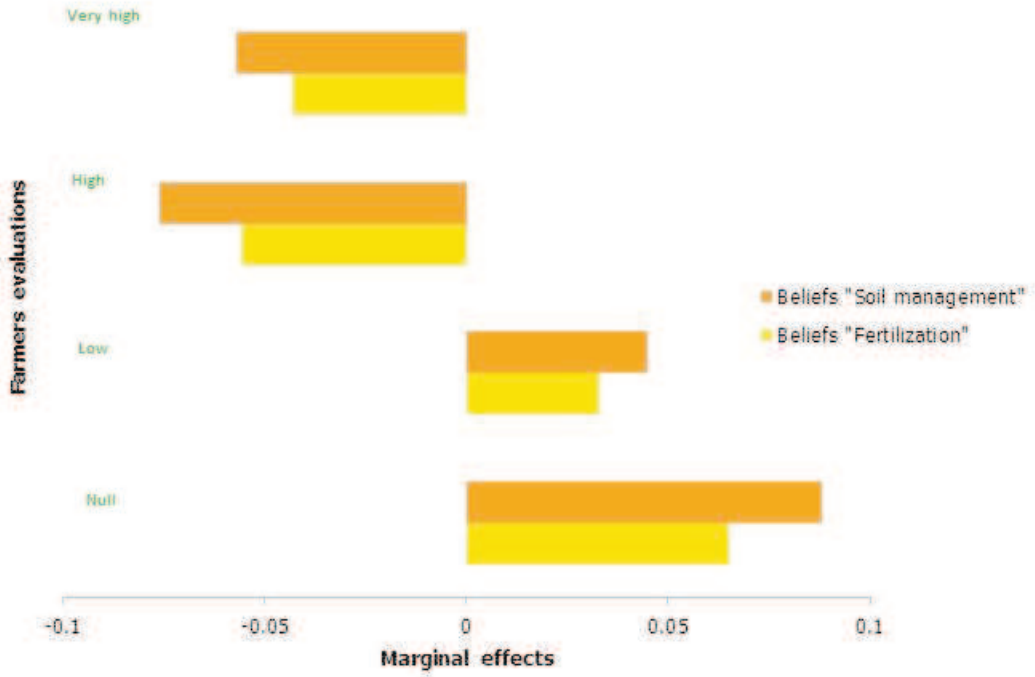
Among the *Perceived obstacles* the variables *RESEARCH* and *INFORM* have statistically significant average marginal effects (Graph. 3). *RESEARCH* captures the idea of the farmers on how the lack of research may limit the adoption of the new technology. The lack of research increases the probability of *Very high* rank and reduces the remaining level of evaluation. Therefore, the result show that the more intensive is the perception of the research gap, the larger is the expected contributions of the agricultural practices to climate change mitigation. In other words, the respondents condition the agricultural contribution to the filling of the existing research gaps. The information lack reduces the probabilities of the agricultural contributions except than for the low level. This evidence indicates that the farmers do not perceive the lack of information as a limit and that the information available can be thought of as being adequate. The attention of the respondents is attracted by the technology available rather than the information streams about it. Also in these cases impacts of the variables vary with the ranks. *RESEARCH* decreases by the 5.12% the probability that the rank is 1, while *INFO* increases by 4.63%.The variable *RESEARCH* decrease the probability of rank=2 by -2.62% while rep_inf increase it by 2.37%. The impact of *RESEARCH* for the rank 3 and 4 – by 4.4% and 3.34% respectively – and negative for rep_inf (-3.98% and 3.02%). The variable clim_inc has a negative impact on the first rank (-4.52% -2.31%) and positive on the remaining two (3.38% and 2.95%). The impact of the variable asse_2 becomes larger as the rank pass from 1 to 4: it is negative and very small (-0.02%) for the rank 1 and becomes 3%, 5% and 3% in the remaining case.

The Beliefs variables have statistically significant AMEs for all the four ranks. Therefore, the respondents' believe that the contribution of the specific farming practices (reduction of fertilizers and change of soil management etc) have just a weakly impact on the policy challenges concerning climate change. To assess this evidence is necessary to consider how much the public representation is grounded on these practices. Also in these cases impacts of the variables vary with the ranks. The impact of the public funding becomes larger as the rank pass from 1 to 4: it is negative and very small (-0.02%) for the rank 1 and becomes 3%, 5% and 3% in the remaining case. Furthermore the positive result strengthens the confidence in both practice and in policy making.

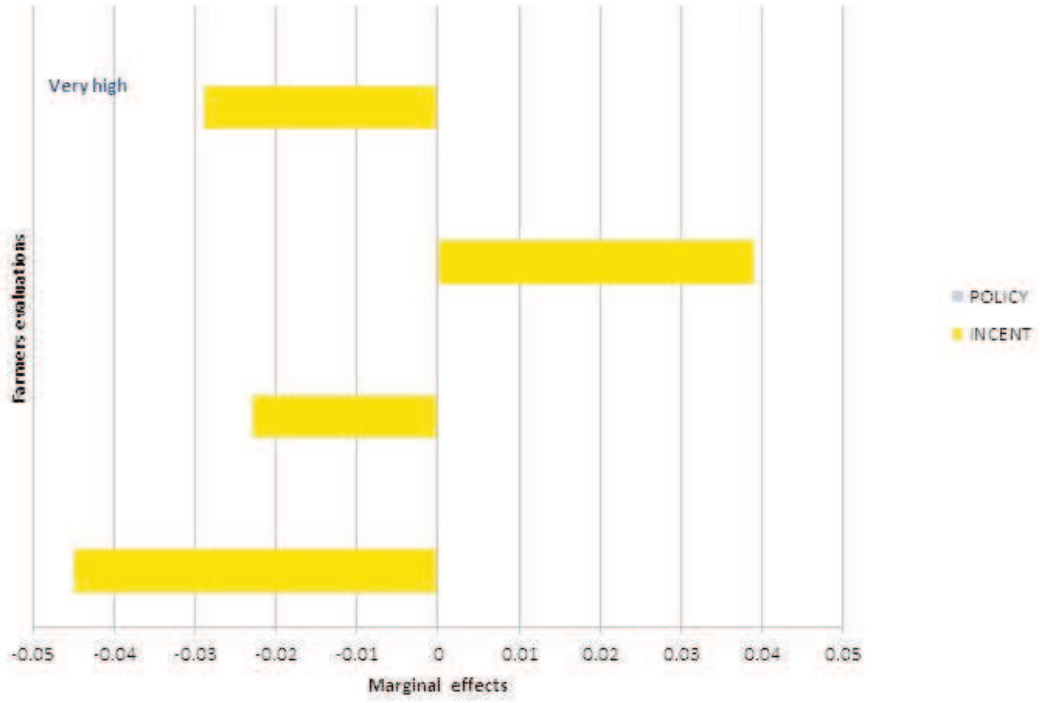
Further information are provided by the examination of the predicted probabilities when both beliefs and the experience (*PRACT_CLIM*) are jointly considered. For *BEL_FERT*, if the respondent has already experience, the probability of each score of assessment is lower than in the case of absence of experiece, except than for the score 3 and for the case of *BEL_FERT*=2 for the score 4. The assessments at score 3 are the largest, indicating that *BEL_FERT* tends to increase the score assigned to the evaluation made by the farmer. However, this effect decreases as the strength of *BEL_FERT* increases. For example, the probability of assigning a score = 2, for *BEL_FERT* =2 and *PRACT_CLIM*=1, is larger than

the probability to assign a score 3 (0.4613 instead of 0.3572). When *BEL_FERT* =1 or 2 and *PRACT_CLIM*=0, the probability of score 2 is larger that the probability of a score 3. Expanding on this kind of comparison, we see that in the case of absence of previous exprience, scroe 2 prevails on score 3 even if the strength of *BEL_FERT* increases. On the contrary, the score 3 prevails on score 2 when the rerspondent has a prevous experience except than for *BEL_FERT* =2. The evidence indicates that the relation between *BEL_FERT* and *PRACT_CLIM* varies. The lack of experience reduces the score of while a previous experience increases but non at maximun value. Furthermore, comparing the influence of *Practi_clim* for each score we have to point out htat experience increases the score except than for *BEL_FERT* = 0. Finally, *BEL_FERT* =2 increases the probability of each score while score 2 or 3 the probability of score decrease with *BEL_FERT.* The remaining beliefs exihibit similar patterns and in general the predicted probabilities increase in the cases in which the farmers believes that the technology may contribute to the mitigation, but the largest probabilities are assigned to the score 3, with low influence of the current experience.

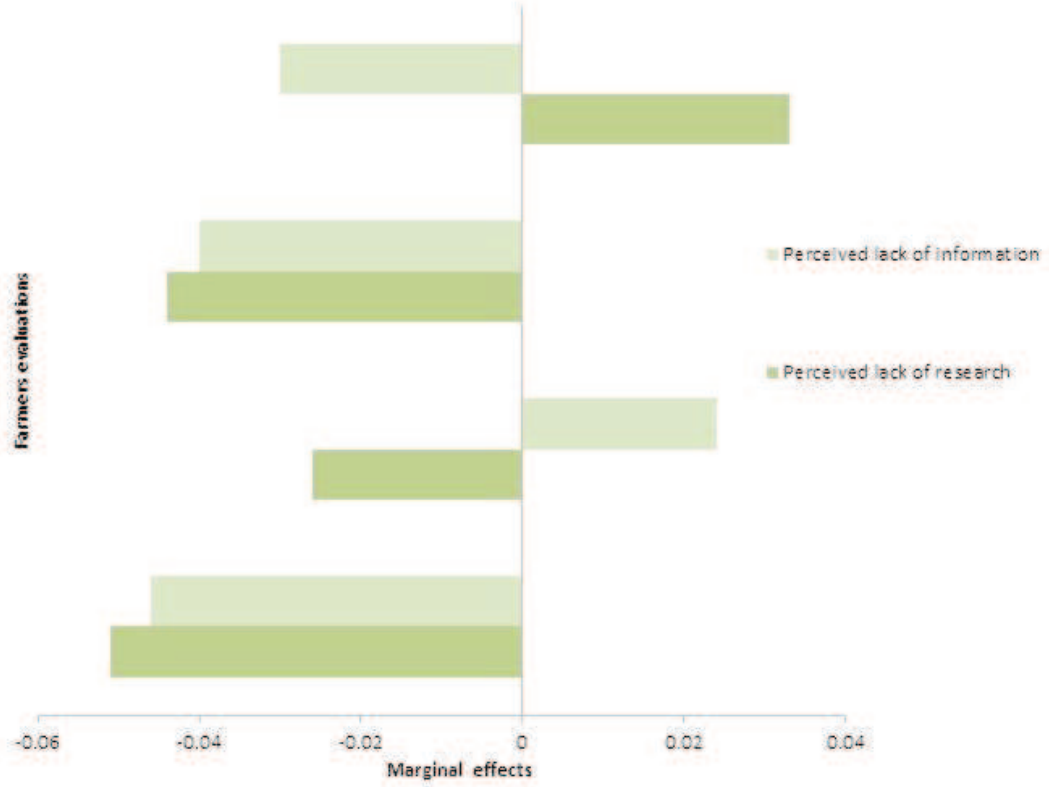
Graph 1. Marginal effects of the farmers beliefs



Graph 2. Marginal effects of incentives and policy



Graph 3. Marginal effects of the public representation



Conclusions

The new CAP is aimed to support and speed the transition of European Agricultural towards a more sustainable model. From an environmental perspective this has to be translated in the transformation of the actually sustained virtuous practices from voluntary and innovative to conventional ones. A process that need a new consciousness and culture of farmers and society with respect to the production of environmental public goods by the agricultural sector. A process departing from an increased and broader farmers implementation of CAP agri-environmental measures and leading to a largely shared pro-environmental behavior. The process is increasingly influenced by the farmers belief on the effectiveness of the practice that these measures foster to impact on the mitigation af climate change as well as to encounter the new social and market environmental needs. From the analysis emerge two implications for the EU environmental policy: considering the construction of incentives and of the measures as an "on-going process" that need direct, participatory involvement of farmers, in particular those who have already experimented innovative environmental friendly practices and constructed positive opinions and attitudes on the effectiveness and the potential of policy measures to sustain the innovation, and the diffusion of the good results coming from the implementation of the effective new practices both at producers and consumers level to create common shared knowledge of them and their contribution to face the environmental challenges. This simultaneous approach to the practices construction and to the strengthening of the farmers and consumers/citizens beliefs on their effectiveness can results in a faster and broader implementation, acting as a multiplier, and however, encourage a synergic management between environmental measures and new possible activities.

A further point to be made concerns with the direction the intervention may undertake with respect to the farm strategies. Olesen and Bindi (2002) claimed that supporting a multifunctional role of the farming may favour the reduction of the potential effects of the climate change and the impact of the agriculture of the climate. The empirical results point out that there is room at farm level for rooting this kind of strategies in technology implementation. This call for the attention of policy maker, especially in considering the opportunities provided by the precision agriculture. Moreover, strategies aimed at supporting process of sustainable intensification (Pretty, 2008), can also integrate the farmers beliefs about adaptation. Along both the direction policy intervention can also support viable path of research development.

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